

SKELETAL SYSTEM

Bone as an organ system:

1. Bone is a CT (cells, fibers & matrix)
 - a. osteocytes
 - b. collagen fibers
 - c. calcium phosphate matrix (*hydroxyapatite*)
2. Dynamic living tissue: self-repair, adjusts to new loads
3. Stores calcium, fat, and makes blood cells
4. Vascular: numerous blood vessels (transport)
5. Innervated

Specific functions of bone tissue:

- Structural support for the entire body
- Storage of minerals (calcium) and lipids (fat)
- Blood cell production (Hematopoiesis)
- Protection (rib cage, skull, spinal column)
- Leverage (muscle attachment = movement)

Bone tissue has four types of bone cells:

1. Osteoprogenitor (stem) cells - undifferentiated
2. Osteoblasts - produce new bone matrix (*osteoid*)
3. Osteocytes
 - = mature osteoblasts surrounded by their own matrix
 - cycle/recycle calcium levels in the bone matrix
4. Osteoclasts - remove bone matrix (osteolysis)

Long bone structure:

- Diaphysis: tubular shaft
- Epiphysis: expanded area at ends
- Metaphysis: zone btw. diaphysis & epiphysis (young)
- Epiphyseal line: remnant of metaphysis (old)
- Nutrient foramen: hole in diaphysis for blood vessel
- Marrow cavity: cavity within diaphysis
- Yellow bone-marrow: contains fat cells
- Red bone-marrow: contains blood cells (*Hematopoiesis*)

Periosteum: membrane on ext. surface (2 layers):

1. outer fibrous layer: muscle attachment, growth limiting
2. inner osteogenic layer:
 - osteoclasts remove bone / osteoblasts add bone

Endosteum: membrane on int. surface (medullary cavity)

- single layer of epithelial cells
- contains osteoclasts and osteoblasts

Vascular supply of bone:

- Nutrient artery - medullary cavity (bone marrow)
- Periosteal arteries - br. nutrient a. (peri- + endosteum)
- Metaphyseal arteries - bone ends (meta- + epiphyses)

Structural types of bone:

Compact bone = compact *lamellar bone* appears 'solid'

- Osteon is the fundamental unit - concentric lamellae
- Central (*Haversian*) canals carry a./v./n.'s
- Perforating (*Volkman's*) canals permit communication (a./v.) between adjacent lamella
- Holes between lamellae (lacunae) filled w/ osteocytes
- Osteocytes communicate via central canal & canaliculi

Trabecular bone = *Cancellous bone* appears 'spongy'

- osteocytes are randomly located along trabeculae
- Haversian canals & osteons are NOT present
- canaliculi found throughout the trabecular meshwork
- osteocytes get nutrition via diffusion
- trabecular bone is very strong for its weight

**Diaphyses are typically made of compact bone.*

**Epiphyses are typically made of trabecular bone.*

Three types of Cartilage (CT: cells, fiber, matrix)

- Tough, resilient, avascular gel, capable of fast growth

1. Hyaline (common): collagen fibers

*Ex: ribs, sternum, joint surfaces, & **developing bone***

2. Elastic: Elastin fibers

Ex: outer ear, tip of nose

3. Fibrocartilage: densely interwoven collagen fibers

Ex: pubic symphysis, intervertebral disks

Two methods of bone formation:

1. Intra-membranous ossification

- Fibroblasts arranged throughout sheet of fibrous CT
- Fibroblasts differentiate into osteoblasts
- Osteoblasts lay down bone matrix
- Trapped osteoblasts (in lacuna) become osteocytes
- Osteocytes generate matrix of collagen fibers
- Calcium infiltrates the matrix > ossification center
- Ossification centers expand around their periphery

2. Endo-chondral ossification

- Fibroblasts differentiate into chondroblasts
- Chondroblasts produce hyaline cartilage matrix
- Cartilage grows to approx. bone shape (model)
- Cut-off from blood supply, dying cartilage cells calcify
- Fibroblasts in perichondrium becomes osteoblasts
- Osteoblasts lay down thin cuff of bone matrix
- Blood supply removes old calcified cartilage
- Diaphysis fills-in with spongy bone > growth
- Diaphysis is soon hollowed-out to form medullary cavity

Growth of long bones

Components:

- Primary oss. center @ diaphysis
- Secondary centers @ epiphyses
- Epiphyseal plate (cartilage) btw diaphysis/epiphysis
- * *Epiphyseal plates can be used to estimate age*

Growth in bone length:

- Primary/secondary ossification centers expand
- Growth cartilages (epiphyseal plates) expand until...
- Cartilage growth slows, epiphyseal plates close
- Diaphysis fuses with epiphyses = growth stops

Growth in bone diameter: *Appositional growth*

- new bone matrix made by osteoblasts (periosteum)
- old bone matrix destroyed by osteoclasts (endosteum)